(2)

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

AN INFORMATION SYSTEMS ARCHITECTURE
ANALYSIS FOR NAVAL AIR SYSTEMS COMMAND

by

Kamin A. Bell

March, 1992

Thesis Advisor: LCDR Robert L. Knight

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b. OFFICE SYMBOL *(If applicable)* 37	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School	
6c. ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000		7b. ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (*City, State, and ZIP Code*)		10. SOURCE OF FUNDING NUMBERS	
		Program Element No	Project No / Task No / Work Unit Accession Number

11. TITLE (*Include Security Classification*)
An Information Systems Architecture Analysis for Naval Air Systems Command (Unclassified)

12. PERSONAL AUTHOR(S) Bell, Kamin Adrienne

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*year, month, day*)	15. PAGE COUNT
Master's Thesis	From To	March, 1992	83

16. SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17. COSATI CODES			18. SUBJECT TERMS (*continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUBGROUP	Information Systems Architecture, Information Systems Planning, Information Engineering, Enterprise Architecture Planning

19. ABSTRACT (*continue on reverse if necessary and identify by block number*)

The Naval Air Systems Command (NAVAIR) is seeking to improve its information resource management (IRM) through the use of information systems (IS) architectures. Although several attempts have been made, NAVAIR currently has no overall IS plan. Enterprise Architecture Planning (EAP) is a comprehensive planning methodology that allows organizations to rapidly adapt and survive in dynamic environments. The use of EAP and the tools and resources currently available will provide NAVAIR with a strategic advantage in an era of diminishing resources. This thesis presents NAVAIR with an analysis of methodologies and tools which will prove useful in the development of an overall information systems architecture.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION	
[X] UNCLASSIFIED/UNLIMITED [ ] SAME AS REPORT [ ] DTIC USERS	Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL LCDR Robert L. Knight	22b. TELEPHONE (*Include Area code*) (408) 646-2771	22c. OFFICE SYMBOL 54kt

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

Approved for public release; distribution is unlimited.

An Information Systems Architecture Analysis
for Naval Air Systems Command

by

Kamin A. Bell
Lieutenant, United States Navy
B.A., Franklin and Marshall College, 1985

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
March, 1992

Author: Kamin A. Bell
Kamin A. Bell

Approved by: Robert L. Knight
LCDR Robert L. Knight, Thesis Advisor

Daniel R Dolk
Prof. Daniel R. Dolk, Second Reader

Stephen L. Mehay
Prof. David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

The Naval Air systems Command (NAVAIR) is seeking to improve its information resource management (IRM) through the use of information systems (IS) architectures. Although several attempts have been made, NAVAIR currently has no overall IS plan. Enterprise Architecture Planning (EAP) is a comprehensive planning methodology that allows organizations to rapidly adapt and survive in dynamic environments. The use of EAP and the tools and resources currently available will provide NAVAIR with a strategic advantage in an era of diminishing resources. This thesis presents NAVAIR with an analysis of methodologies and tools which will prove useful in the development of an overall information systems architecture.

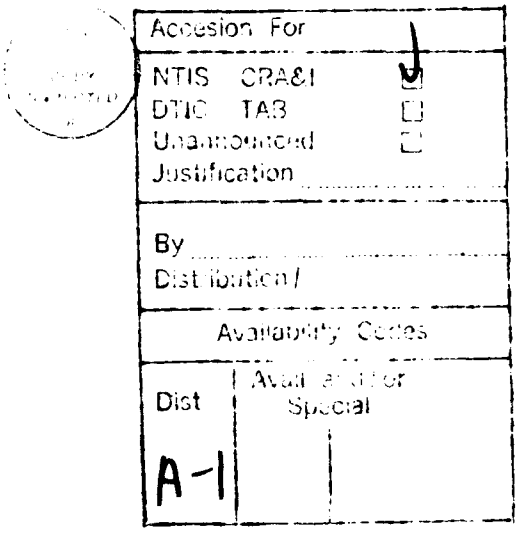


TABLE OF CONTENTS

I. INTRODUCTION

A. PROBLEM STATEMENT

The Department of Defense has received much criticism in recent years for the mismanagement of its information resources and automated data processing. Previous practices in the management of information systems have been quite costly. Business methods have been developed on an ad hoc basis resulting in numerous redundant computer systems. Minimal standardization of data across the DOD has reduced portability and integration capabilities of current applications. The Department has now shifted towards viewing information as a valuable resource, attempting to accurately document and plan information systems, thereby insuring more cost effective, integrated systems are developed.

The Naval Air Systems Command (NAVAIR) is seeking to improve its information resource management (IRM) through the use of information systems (IS) architecture. Although several previous attempts have been made, NAVAIR currently has no overall IS plan. Without an IS architecture they must make reductions in resources and programs with little grasp of what aspects of their organization are critical to its success. It is essential for NAVAIR to have an IS architecture to ensure

budget decisions are made from the most informed posture possible and that their reduced resources are managed effectively.

B. BACKGROUND

In October of 1989, the Department of Defense established the Corporate Information Management (CIM) initiative in response to a Defense Management Report (DMR) condemning DOD IRM business practices. CIM has been implemented in the private sector and was chosen based on its ability to overcome problems similar to those which have plagued the DOD:

> including management structures, staffing levels, and entrenched corporate policies and cultures that impeded decisionmaking, frustrated innovation, obscured accountability for success and failure, and imposed excessive overhead costs. [Ref. 1: p. 15]

The objective of CIM is to "increase the effectiveness of information management while reducing the costs of information management to the Department." [Ref. 2: p. 6] CIM emphasizes interoperability and consistency between DOD components through the use of an open architecture, common data definition, and standardization of information resources, all of which facilitates the sharing of information.

The Department of Defense identified eight administrative functional areas which have common information requirements within each service. Consolidation of related functions and the elimination of unnecessary management layers within these

areas will increase their efficiency while lowering overall costs. [Ref. 1: p. 16] The eight functional areas are:

- Civilian Payroll
- Human Resources
- Contract Payment
- Distribution Center (or Warehousing)
- Material Management
- Financial Operations
- Medical
- Government Furnished Materials [Ref. 3: p. 3]

A Functional Group is assigned to each area and is tasked with developing an IS strategy that is both unified and standardized at the DOD level as opposed to the individual service or agency level.

Designed as the vision of DOD in the year 2000, CIM is comprised of fourteen guiding principles. Several key principles are:

- Information will be managed through centralized control and decentralized execution.
- Proposed and existing business methods will be subject routinely to cost-benefit analysis which includes benchmarking against the best public and private sector achievement.
- Information systems performing the same function must be common unless specific analysis determines they should be unique.
- The computing and communications infrastructure will be transparent to the information systems that rely upon it.

- Common definitions and standards for data will exist DOD-wide.
- Data will be entered only once. [Ref. 4: p. 3]

These principles apply to all DOD components and must be incorporated in existing IRM plans and adapted to fit each particular mission.

Interoperability between the armed forces is a major premise of CIM, as four different methods of resource management are merged into one. An even greater task lies within each service as no common IS plan exists. A division of labor has been established to prevent duplication of effort but the immense size of this initiative necessitates several years for completion of initial modules.

The Department of Navy has significantly increased its attention on IRM efforts in recent years, however budget cuts have hampered these efforts. Furthermore, funds originally designated for IRM departments have been rerouted to the CIM initiative. New developments and modernizations have been severely restricted to mission essential programs. Moreover, the vast size and the large number of components within the DON make documentation and planning an enormous assignment. The DON issued the Information Resources Strategic Plan of April 1991 as a primary reference to assist Navy components in defining their IRM requirements. The IRSTRATPLAN is a timely document which clearly defines the IRM mission and scope as set forth by the DON and is consistent with the CIM

initiative. The plan discusses five key issues which delineate the DON overall IRM strategy. These issues include:

- Information architecture
- Requirements, planning, budget, and execution
- Acquisition process
- Telecommunications and computing infrastructure and supporting technology
- Workforce development. [Ref. 5: p. iii]

The IRSTRATPLAN provides guidance necessary for each DON component to begin defining its IRM requirements.

Information systems architecture methodologies are effective tools in creating strategic plans for an organization. Some of the methodologies that exist today to assist in the management of information resources are Business Systems Planning (BSP), Information Engineering (IE), and Enterprise Architecture Planning (EAP). While there is no consensus on which methodology is the "best", the underlying principle is the need for a comprehensive understanding of the flow of information within an organization and how that information is utilized. IS architecture provides organizations with the ability to assess their current situation and develop strategies for meeting future requirements.

Information systems architecture is a discipline designed to develop a road map of information requirements throughout an organization. Major components of IS architecture include:

- Data architecture - physical mappings, corporate and user views.
- Application architecture - business process groupings presented to the end-users.
- Geographic architecture - maps the information requirements for strategic locations within the organization.
- Technology architecture - determines the technology required to meet all other architectures. [Ref. 6: p. 17]

Currently within DOD there exists a "multiplicity of unique information system architectures with incompatible hardware, software and communications networks." [Ref. 4: p. 18] The inability to integrate systems prohibits essential sharing of data both within and across the services. The CIM initiative addresses this problem by mandating the use of a common information architecture framework by the services to ensure standardization. Furthermore, it is essential that both CIM and non-CIM systems are capable of communicating.

The purpose of this thesis is to provide the Naval Air Systems Command's (NAVAIR) Information Resources Management (IRM) Division (AIR-713) with an analysis of methodologies and tools to assist the division in creating an information systems architecture. The IRM division is responsible "for formulating policy, planning, budgeting, directing,

administering and exercising oversight of the NAVAIR IRM Program, for all non-tactical information systems (ISs) and associated resources." [Ref. 7: p. 1-1] The selection of standard methodologies and tools within CIM is not expected for at least another year. NAVAIR must select a broad methodology which has the ability to use many different techniques and tools, facilitating easy adaptation within CIM. NAVAIR will be setting its own IS planning standards to be promulgated throughout its command until the CIM standards are complete.

C. RESEARCH QUESTIONS

The questions this thesis will address are as follows:

1. What is NAVAIR's current information systems architecture plan?
2. What information systems efforts are currently being developed within NAVAIR?
3. What "culture" exists in NAVAIR to enhance/deter the implementation of a new Information System Strategy?
4. What methodologies are most effective in determining information systems requirements?
5. How have IEF CASE tools changed in the last two years and do they have the capability to be integrated with other CASE tools?
6. Which methodology and tools will be able to increase the effectiveness and efficiency of NAVAIR by improving the structures and uses of information?
7. What are the benefits to NAVAIR exist from utilizing the methodology and tools selected?

Chapter II will provide an overview and comparison of methodologies available for architectures within the constraints set forth by CIM. The architectures discussed are Enterprise Architecture Planning and Information Engineering.

Chapter III will provide NAVAIR with a baseline architecture from which to begin their overall IS plan. A baseline architecture corresponds to the Business Modeling phase of EAP, discussed in Chapter II. In addition, two previous NAVAIR architecture efforts will be analyzed: NAVAIR Division-04 (AIR-04) Information Strategy Plan (ISP) and the Component Information Management Plan (CIMP).

Chapter IV will evaluate barriers to implementation of an IS architecture. It will provide some insight as to how to avoid and manipulate such barriers as: approaches to planning, organizational culture, political climate and senior management involvement.

Chapter V will include conclusions and recommendations for NAVAIR Information Resource Management division. Future thesis topics will also be provided.

Information systems architecture will prove to be a crucial tool for structuring and manipulating information in the future. NAVAIR needs an information architecture to document current systems and to determine where they would like to be in the years to come. With more reductions in the IRM budget expected, this thesis will provide critical research for NAVAIR with substantial savings of both time and

money. This thesis presents NAVAIR with an analysis of methodologies and tools which should prove useful in the creation of an overall information systems archtecture.

II. INFORMATION SYSTEMS ARCHITECTURE METHODOLOGIES

A. THE NEED FOR AN IS ARCHITECTURE

The need for information systems architecture has gained considerable momentum in recent years. Rapid advancements in computer and information technology have had an enormous impact on the organization's allocation of resources and more importantly on the strategic goals of businesses. Furthermore, "since the technology permits 'distributing' large amounts of computing facilities in small packages to remote locations, some kind of structure (or architecture) is imperative because decentralization without structure is chaos." [Ref. 8: p. 276] An IS architecture has become an essential requirement to the survival of any organization in today's information age.

There is little consensus on the definition of, or procedures used, in an IS architecture. As mentioned in Chapter I it can be a "road map" or a "high-level map of the information requirements of an organization." [Ref. 9: p. 198] IS architecture can be used as a planning guide for "long-range development but also allow response to diverse short-range information system demands." [Ref. 10: p. 122] Each interpretation illustrates the importance of IS architecture

as a tool for documenting and developing an organizations strategy for the future.

Planned systems offer many potential benefits to an organization. The containment and reduction of costs has become vitally important to organizations today. Architectures facilitate reduction in data entry, increased productivity, and identification and elimination of complex interfaces between incompatible systems, all of which reduce costs. The increase in the timeliness of data and the access to shared data further contribute to cost savings as management is able to make better informed decisions. [Ref. 11: p. 3EAP1-9]

The phrase "potential benefit" is very significant in systems planning. Many different IS architecture methodologies are on the market today. While many organizations have attempted IS planning few organizations have succeeded in implementing them. Many obstacles must be overcome to effectively use any methodology:

- Awareness/Recognition/Acceptance by top management
- Commitment of resources (staff and funds)
- Lack of credibility of planning leaders (IRM/DA)
- Finding the 'best' methodology; Inadequate tools
- Educating DP people in new technologies
- Crises today leave no time for planning (other excuses)
- Substantial up-front cost; Benefits difficult to measure

- Inaccessible or uncooperative users; Delegation. [Ref. 11: p. 3EAP2-4]

Of those obstacles listed above, support from top management and the commitment of resources are most critical.

This chapter provides an analysis of one methodology that has emerged in the past few years, Enterprise Architecture Planning (EAP). EAP has been successfully implemented in Canada but is only now gaining recognition in the U.S. A comparison and contrast of EAP with the widely used methodology, Information Engineering, will conclude the chapter.

B. ENTERPRISE ARCHITECTURE PLANNING

1. Overview

Enterprise Architecture Planning is "the process of defining *architectures* for the use of information in support of the business and the *plans* for implementing them." [Ref. 11: p. 3EAP1-2] The key word in the above statement is "defining." Many earlier architectures attempted to design structures for the organization prior to defining the organization itself. EAP emphasizes the planning process from the initial decision to investigate IS architectures through to its implementation. The migration or implementation plan is one aspect of traditional systems planning methodologies which was rarely developed, and which resulted in many failed architecture attempts.

EAP is a data-driven approach rather than process-driven. A strong knowledge base of the organization is gained through the functional business model that is developed using EAP. The data architecture should be completed prior to the applications architecture to allow data dependencies to determine the overall plan. Furthermore, EAP allows for both short- and long-term planning which is critical to establishing operational and strategic goals of an organization. [Ref. 11: p. 3EAP1-7]

There are many business benefits of EAP. Each of the following benefits works in conjunction with the potential benefits of planned systems mentioned earlier:

- Perspective focus on strategic use of technology for managing data as an asset
- Standard vocabulary facilitates communication, reduces inconsistency and data redundancy
- Documentation increases understanding of the business
- Process considers integration of current systems with the new
- Cost-effective long-term solution considers rate of return
- Methodology facilitates easier assessment of the impact of new systems
- Modeling allows easier accommodation of dynamic business changes such as acquisitions, budget reductions, lines of business, etc.
- Management participation provides a business perspective, credibility, confidence, and demystifies system development. [Ref. 11: p. 3EAP1-8]

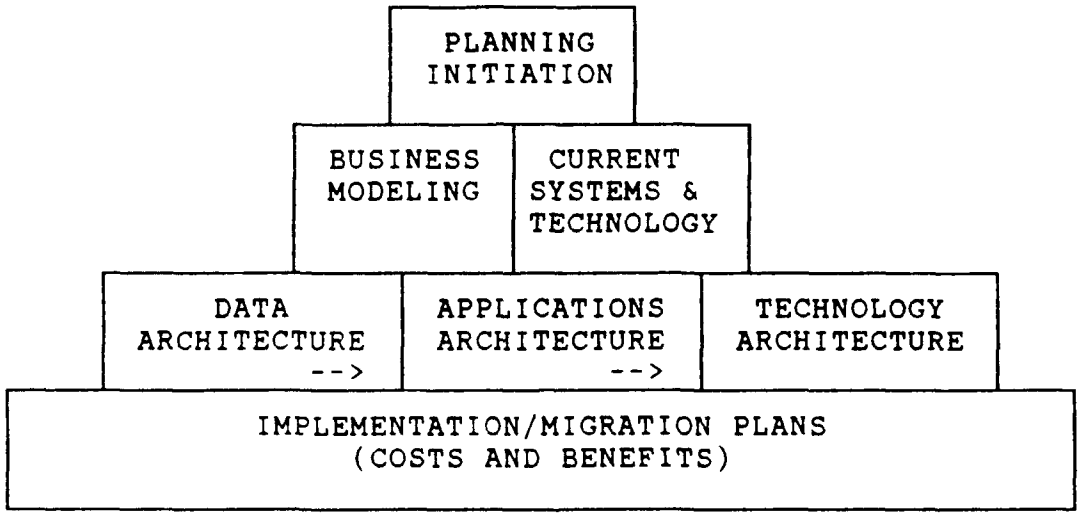
Success is measured in Enterprise Architecture Planning as: the project was completed, the plan is being implemented, and "the architectures are used to guide the development and are maintained current." [Ref. 11: p. 3EAP2-1] The reason EAP has been successful is that it is not a technical document. The focus is on managing and planning. Furthermore, the commitment and support of management is gained at the outset and maintained throughout the process. Participation from management and end-users, with an equal representation of business and systems personnel, allows for greater ownership of the project and greater cooperation. An "acceptable balance of scope/objectives vs. level of detail vs. resources and time committed" also adds to EAP successes. [Ref. 11: p. 3EAP2-5] The organization's culture is identified early and the plans are developed to fit the culture. A completed architecture that ignores corporate culture will not be accepted and will ultimately fail. Intermediate deliverables are distributed within the organization to provide constant communication and feedback and ensure ownership is continued.

Throughout the phases of the project, the 80/20 Rule must be followed, i.e. capture 80 percent of the knowledge and data information benefits with 20 percent of the effort. Planning is imperfect and time consuming. The EAP methodology insists that the best personnel be used. To do this, the "best" people must take time away from other tasks which

ensures productivity during each meeting resulting in completing phases on schedule.

2. **Methodology**

The components of Enterprise Architecture Planning are managed in a pyramid formation:



A great deal of effort is entailed in the top level, Planning Initiation. One premise of EAP is that no methodology can be successful without ensuring an effective and efficient Plan. The second level, Business Modeling and Current Systems & Technology, determines and documents where the organization is today. Once level two is complete, level three, architectures, defines where the organization wants to be in the future. Notice that data architecture is completed prior to applications architecture. The final level, Implementation/Migration Plans, provides the vehicle for the organization to attain its goals. The order in which each

component is conducted is vitally important to the success of an EAP project as each preceding component ensures a strong knowledge base for the component following.

The Planning Initiation phase is comprised of seven steps:

1. Determine Planning Objectives, Scope and Select a Suitable Business Unit
2. Create a Vision (Initial Meetings with Management)
3. Adapt a Planning Methodology
4. Arrange for Computer Resources
5. Assemble the Planning Team
6. Prepare Detailed Schedule and Cost Estimates (EAP Workplan)
7. Obtain/Confirm Commitment and Funding (Executive Presentations) [Ref. 11: p. 3EAP3-2]

Defining the "enterprise" is extremely important in the planning stage. An enterprise may include the entire organization, a division or profit center, or possibly a subsidiary or functional area. In selecting the business unit for EAP, the following characteristics must be evaluated:

FAVORABLE CHARACTERISTICS

- Has current strategic long range business plans
- Emphasis on quality improvement programs
- Need to integrate and share data
- Unsuccessful DP projects or severe cost overruns
- Budget approved for major new system
- Major business changes anticipated
- Extensive management changes or reorganization

- Able and willing to design architectures

UNFAVORABLE CHARACTERISTICS

- Opposites of the above
- Shortsighted management (time, budget, other excuses)
- Recent "unsuccessful" planning attempts
- Hostility or resentment towards systems people
- Uncooperative "hands-off" attitude (delegation)
- Experiencing less profit, potential downsizing
- Lack of or disregard for standards or plans [Ref. 11: p. 3EAP3-5]

Favorable characteristics should outweigh unfavorable characteristics, and a strategy should be formulated to overcome potential obstacles.

An adequately defined scope is crucial to a project if it is to meet the needs of an organization. It should include all areas that share data, or need to share data. A strategy is developed to answer any unfavorable characteristics identified. It is important that the objectives are written in simple, concise, nontechnical language, focussing on the benefits to the organization. The risk of a too narrowly defined scope is that the architecture will be incomplete and independent causing integration problems. Alternately, if the scope is too broad the project will have insufficient detail and take too much time. Any issues or problems must be addressed at this stage to have complete confidence of success. [Ref. 11: p. 3EAP3-4]

A critical success factor of this planning phase is the need to understand corporate culture. While much attention has been given to culture in recent years, there is

little consensus on its definition. One definition of culture is:

> a pattern of basic assumptions-invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration-that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems. [Ref. 12: p. 9]

Another definition states that "the purpose of culture is to provide members with a sense of identity and to generate a commitment to beliefs and values that are larger than themselves." [Ref. 13: p. 14]

Understanding and documenting culture is quite complex. Corporate cultures are a reflection of their leaders and without their visible support, an architecture effort will encounter "a counter-cultural effort to implement cooperation and some centralized decision making." [Ref. 14: p. ID/2] There are several different techniques for evaluating cultures (Figures 1 and 2). These methods identify specific characteristics (i.e. entrepreneurial, competitive, participative) which exemplify the organization. Through careful examination of an organization's culture an EAP plan can be developed within the constraints of the culture, ensuring critical commitment and cooperation throughout the organization is achieved.

A vision statement merges the project's scope with the organizational culture to invoke enthusiasm and support. It

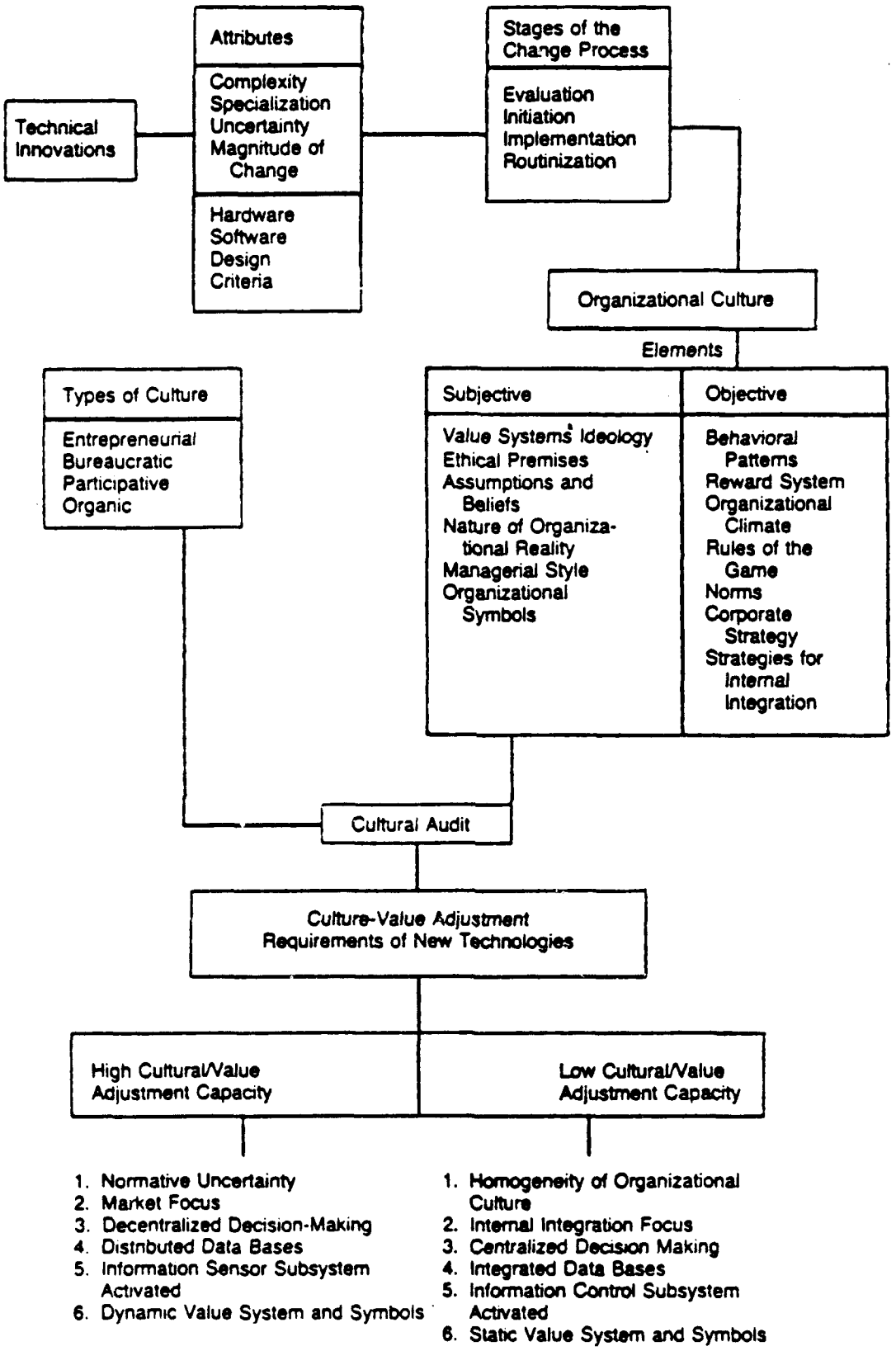


Figure 1. A Conceptual Framework of Organizational Culture and Change [Ref. 13]

ENTREPRENEURIAL	**CONSERVATIVE**
Risk Encouraging	Risk Averse
Informal	Formal
Decisive	Deliberate
Results Oriented	Process Oriented
Aggressive	Defensive
CLEAR AUTHORITY LINES	**AMBIGUOUS AUTHORITY**
Functional or Divisional	Matrix
Profit and Loss Responsibility	Cost and Revenue Centers
Hierarchical	Consensual
COOPERATIVE	**COMPETITIVE**
Team Oriented	"Macho"
Collaborative	Individualistic
Reward Oriented	Censure-oriented
Merit Based	Power Based
LED	**MANAGED**
Long-Term Goals	Short-Term Objectives
Clear, Enduring Mission	Mixed Messages
Big Picture Oriented	Detail Oriented
Creative	Analytical
ETHICAL	**AMORAL**
Visible Ethics and Policies	Tacit Acceptance of Unethical Behavior
Ethical Leadership and Supervision	Hiring for Cultural Fit
Internal Checks and Balances	No Attention to Reconciliation Between Systems

Figure 2. Dimensions of [Corporate] Culture [Ref. 15: p. ID/2]

depicts the target environment the enterprise is working towards. The most famous vision statement was delivered in 1961 by President John Kennedy: "'We will put a man on the moon, and return him safely to earth, by the end of the decade.'" [Ref. 14: p. 6] Another example would be a president of an insurance company wanting policy holders to complete their intended objective in a single telephone call. A vision statement is simply one that identifies the organization's aspirations for the future.

A unique and critical aspect of EAP is that other IS methodologies can be incorporated into the project. Again, EAP is a defining and planning process, and therefore, any methodology that can assist in the process is viable. The following methodologies and teachings can be applied to EAP:

--> IBM's BSP, BSPI, and BSPX
--> Books by James Martin and Others
--> Information Engineering (JMA, PIM, Knowledgeware, PDC)
--> SSP and TSP (Holland)
--> System Architecture (Nolan) and
Investment Strategy (Norton) [Ref. 11: p. 3EAP3-12]

The methodology chosen should be easy to understand, compatible with the existing culture/politics, utilize automated tools, and produce a long-range implementation plan. Consultant firms trained in EAP are also an option, but can be costly and time consuming. Once selected, the methodology must be tailored to meet the needs of the particular organization.

The steps involved in the Planning Initiation component all combine to win commitment from top management. The project is scoped and the enterprise selected, a vision statement is promulgated which encompasses the entire organization, a methodology is adapted, dedicated computer resources are arranged, a skilled and highly credible planning team assembled, and schedules and estimates prepared, all with the expressed purpose of the executive presentation(s). This is a very political process and must be recognized as such. Proving the need for an EAP, or equivalent architecturing effort, is essential. Themes should be used which provide ownership throughout the organization (management, programmers, end-users) with phrases such as: "We must work together toward the same goal". The commitment gained in Planning Initiation must be attended to and nurtured throughout the EAP project.

Once the planning phase has been completed, commitment achieved, the EAP team shifts to level two; understanding and documenting current organizational structure and business functions. Using the toolset selected earlier, new organization charts are created to include organization units, reporting structure, locations, as well as business goals and objectives. This can be a very time consuming process and the team must stay quite focused. [Ref. 11: p. 3EAP4-8]

Identifying and defining business functions seeks answers to the question "What is it that 'We' do?" A function

is "any set of actions performed in the course of conducting business" and "is defined entirely by its subfunctions." [Ref. 11: p. 3EAP4-9] Functions should be defined along functional lines versus reporting lines. Decomposition of functions continues "until the functions tend to be single action oriented, executed repeatedly and have identifiable outcomes." [Ref. 11: p. 3EAP4-10] Enterprise surveys, interviews of personnel, are an excellent source of information for identifying business functions. The functional business model (FBM) should be compiled using the toolset chosen, distributed within the organization and presented by a well respected team member.

The Current Systems and Technology component is frequently a subproject that can begin prior to Planning Initiation and can be conducted concurrently. The Information Resource Catalog (IRC) produced in this phase is a valuable document for the architecture components. The IRC entails the following:

- Reference to All Information Resources
  - Application Systems
  - Data (Inputs, Outputs, Files/DBs)
  - Technology Platforms
- Distribution of Information Resources
- Information Locator for Management, Orientation for MIS Personnel
- Baseline for Long Range Planning and Highlights Opportunities
- Budgeting and Cost Control Decisions

- Quick Success at Reasonable Cost, Establishes Credibility
- Internal Use of Documentation Tools [Ref. 11: p. 3EAP6-2]

The IRC is then distributed to the DPs and end-users and becomes the baseline for the data architecture phase.

The third level in the EAP pyramid consists of the three architectures. Each of these conforms to traditional architectural procedures and guidelines. First, the steps involved in creating a data architecture are:

1. List Candidate Entities
2. Define the Data Entities, Attributes and Relationships
3. Relate the Entities to the Business Functions
4. Distribute the Data Architecture

An entity is defined as: "any person, place, concept, thing, or event that has meaning (information) in the context of the business ('an aggregation of data needed for a specific purpose') [Ref. 11: p. 3EAP7-3] Once identified, entities provide valuable knowledge of the characteristics of data and how data relates within an organization. Entity-relationship diagrams are helpful in this phase to illustrate both simple and complex interrelationships that exist within the data architecture.

In relating entities to functions, toolsets generate matrices using the lowest level of each function. A data entity is identified as

- Created
- Updated
- Referenced

Only significant relationships, based on entity usage, should be included in the matrix.

The deliverable for the first component is the Data Architecture Report (DAR) which includes a list of entity names, complete entity definition, Entity-Relationship Diagrams, Entity Usage Matrices, and any Data Flow Diagrams. An introduction provides a detailed explanation on how to interpret the DAR.

The second architecture component is the applications architecture. Using the DAR, FBM, and the IRC, all possible applications are listed and defined. Application definitions entail:

- brief purpose
- general description and capabilities
- business opportunities and benefits (tangible, intangible) [Ref. 11: p. 3EAP8-5]

This definition should focus on what it does, independent of technology, and not how the application accomplishes its tasks.

Matrices are again utilized to illustrate relationships between applications and business functions and organizational units. The matrices depict the support status

of the applications: current, modify, replace, planned, needed. Furthermore, an Impact Analysis is conducted to determine if existing applications are to be:

- completely replaced
- partially replaced and modified
- retained with minimal enhancement

The last phase, technology architecture, begins with designing the data/applications distribution architecture. In this step, business locations are associated with data and applications architectures; traffic volumes are estimated. Next, the technology platforms (layers) are defined. The technology configuration (i.e., hardware, software, networks, communications) is selected and costs estimated. Diagramming the configuration is helpful in formulating a vision of how the application and data relate to the technology chosen. Estimates of the resources required are also needed to assess the viability of the technology:

- people (number & types), organizational units and structure
- business impact, procedural changes
- policies and standards
- acquisition and capital expenditures [Ref. 11:p. 3EAP9-4]

The final step of the technology architecture is to confirm applications and technology. At this stage, the

purpose, inputs and outputs for each application are reviewed and any changes to the FBM noted. A description of the "technology 'vision'" is essential in illustrating the benefits and opportunities that will be available with implementation of the architecture. [Ref. 11:p. 3EAP9-7]

While each component resembles traditional architectures, attributes exist that are unique to EAP. Throughout this level, team interaction and discussion is significant and essential. The team composition of both systems and business personnel guarantees the documents will be comprehensive and easy to read. Creativity, inventiveness, and the use of team brainstorming are effective skills utilized in each phase. Furthermore, the team must determine how they define "consensus" as EAP requires it on the definitions of entities and applications. As mentioned earlier, communication both within the team and throughout the organization is important to gain feedback, to confirm that the project is meeting the needs expressed in the planning phase, and to maintain commitment from top management and the organization.

The final stage of the EAP process is the phase most neglected by other IS architecture methodologies. The Implementation/Migration Plans component is what distinguishes EAP most from other methodologies. This component is comprised of three phases: Data Development Plan, Planning Conclusion, and Transition to Implementation.

The Data Development Plan sequences and prioritizes the applications and estimates the effort, resources, schedules, costs, and benefits. Critical success factors (CSF) are determined and recommendations (desired management decisions) are made in this particular phase. The CSFs "are conditions that will contribute to or enable the implementation of the plan to proceed toward a successful conclusion which are either not presently in place or are in jeopardy of an unfavorable change." [Ref. 11: p. 3EAP10-15] Some common CSFs are:

- Immediate initiation of the Transition Phase
- Approval of plan (with initial projects)
- Adopting new system development methods (I.E., O-O)
- Evaluation/Selection/Acquisition/Installation of
  - hardware platforms (network, connectivity)
  - software packages
  - CASE
- Standards and Procedures
- Approval of budget
- Reorganizing I.S.; Shifting responsibilities[Ref. 11: p. 3EAP10-16]

Training requirements for each phase of implementation are also determined, to include DP department personnel and applications and technology end-users.

The second phase of implementation is Planning Conclusion. The final EAP report is prepared and must be consistent with the corporate culture. Strong, emotional

wording, unsubstantiated statements, unlabeled opinions, and controversial subjects should be omitted from the report. [Ref. 11: p. 3EAP11-4] Presentations are prepared and delivered to management "to explain the results of EAP and the plans, and ultimately to obtain their approval or support to proceed with the implementation." [Ref. 11: p. 3EAP11-6] Presentations are also made to every department within the enterprise.

The final phase of the entire EAP project is Transition to Implementation. There are eleven steps to be completed:

1. Plan the Transition
2. Adopt a System Development Approach
3. Arrange for Computer Resources
4. Refine the Architectures
5. Institute Organizational Changes
6. Recruit Implementation Personnel
7. Provide Thorough Training
8. Establish Programming Standards
9. Establish Procedural Standards
10. Develop a Detailed Workplans for the First Group of Applications
11. Confirm the End of Transition [Ref. 11: p. 3EAP12-2]

Evident by this extensive list of steps is the comprehensiveness and attentiveness of EAP to validate the implementation process and guarantee success. A transition phase workplan is developed to address and schedule the above steps, as well as: plan for the acquisition and installation of hardware and software, develop a strategy for managing political obstacles, determine approaches to and projects for

prototyping, and schedule the recruiting and training of personnel. The workplan is a thorough attempt to confirm that all avenues and obstacles have been examined prior to implementation.

Essential throughout the EAP process, and specifically during the transition phase, is the need to maintain high enthusiasm and momentum for both the team members and the organization. Steady progress is imperative. Resistance to change can retard, if not destroy, an implementation plan and, therefore, must be effectively managed. The transition phase requires strong leadership and direction to allow implementation to proceed.

3. Assessment of EAP

Enterprise Architecture Planning is a thorough methodology for information systems planning. From the selection of team members, to the care and attention given to each step of each component, EAP is exhaustive in its efforts. Costly, redundant systems are identified and eliminated. Applications are developed quicker and along functional lines, increasing productivity and improving user skills. Critical management decisions are based on more accurate and timely data, effecting a more stable, cost-efficient organization.

EAP is an objective and impartial approach to IS architectures. Organizational participation allows everyone to take ownership of the effort. The continuous communication

and distribution of intermediate deliverables provides constructive feedback to verify the project is meeting the needs of the organization. A viable migration strategy is developed for both long and short term plans to effect smooth implementation. The flexibility of EAP allows organizations to rapidly adapt to and survive in dynamic environments.

C. INFORMATION ENGINEERING

1. Overview

Information engineering (IE) is a widely recognized methodology in the field of Information Systems. Information engineering "refers to the set of interrelated disciplines that are needed to build a computerized enterprise based on information systems." [Ref. 17: p. 24] As a data-driven approach, IE has traditionally confined itself to data and data architecture. Other characteristics of IE include:

- It is driven by the user.
- It anchors data processing expenditure in top management's needs and goals.
- It identifies how computing can best aid the strategic goals of management.
- It is based on easy-to-understand diagrams.
- It employs a steadily evolving central repository of knowledge about the enterprise.
- It uses CASE tools to link diagrams with code generators and fourth-generation languages.

- It uses prototypes.
- It assists information center activities.
- It is integrated throughout the information systems function.
- Its goal is full automation of the database and application development process. [Ref. 17: p. 24]

Information engineering merges the talents of users, management and DP personnel in an effort to "identify, implement and process the data that supported the business." [Ref. 16: p. 11] Users and managers are now able to complete much of the design requirements resulting in more complete specifications which reduces the time required for application development, thereby reducing the application backlog.

There are several different versions of information engineering currently on the market. One interpretation by Clive Finkelstein provides extensive integration of CASE tools throughout the IE process. The data modeling components of this version of IE closely coincides with the architecture requirements of NAVAIR. The information engineering methodology discussed in the next section is strictly that of Clive Finkelstein.

2. Methodology

Beginning in 1976, IE's primary focus was on data base design. Several years later it incorporated such techniques as data and information analysis and information systems design. Currently, information engineering has evolved to

include strategic, tactical and operational data modeling. But the focus has not shifted from data. IE's Data Modeling identifies and defines entities and produces Entity Relationship Diagrams. However, IE extends that process to include data mapping which resembles the normalization process used in Data Base Management Systems (DBMS). The purpose of the normalization process is:

> The application of a formal set of rules which determine those key attributes which uniquely identify each data attribute, and which place each attribute in an entity where it is fully identified by the whole primary key of that entity. [Ref. 16: p. 94]

The data modeling process is extensive in the effort to capture all data utilized by an organization.

There is a significant emphasis placed on strategic and tactical planning by IE. Strategic management is accomplished through "communication, execution and management of strategic planning" which leads to successful strategic implementation. [Ref. 16: p. 158] Two main types of strategic planning exist: corporate and systems. Corporate planning is attended to by top management while systems planning has been a function of DP departments. To align these two, systems planning should be incorporated into the corporate planning department.

Several problems which arose from traditional strategic planning are: [Ref. 16: p. 160]

Strategic Planning	Limited strategic alternatives
Strategic Implementation	Ineffective communication Misinterpretation
Strategic Management	Long feedback cycle (3-5 years) Ineffective performance monitoring

Strategic planning in information engineering can be accomplished using either a formal or informal approach. Although the processes are somewhat different, both approaches result in a strategic statement which entails:

- Mission and purpose.
- Concerns and issues.
- Goals and objectives.
- Policies.
- Strategies and tactics. [Ref. 16: p. 175]

The informal planning approach also includes tactical statements which define the objectives and procedures that will assist the organization in rapidly adapting to changes in their environment.

Information engineering has three primary phases: Analysis Phase, Design Phase and Generation Phase. During the analysis phase, data and information required at the strategic and tactical management levels are defined using the strategic

and tactical statements developed prior to the start of the project. The steps involved in this phase are:

1. Project scope
2. Strategic modeling
3. Tactical modeling
4. Operations modeling

The strategic model focuses on high-level, senior management issues with long-term goals, while the tactical model represents middle management interests and short-term objectives. An operations model concentrates on the day-to day operations and objectives of an organization.

The users are primarily responsible for the analysis phase. IE techniques and expert systems are employed to capture the users expert knowledge. The effect of this phase is "the progressive definition of the data resource." [Ref. 16: p. 229] The data is then examined in the design phase to identify common and redundant data, and is mapped to users and functions within an enterprise. It is recommended that the analysis and design phase be conducted concurrently to increase productivity.

The design phase is automated using expert design tools. An exper[illegible]ictionary is used to check the consistency and accuracy of data definitions used by all three models. Common data is combined into integrated strategic, tactical and operations models, and become inputs to the final phase.

> The generation phase defines implementation strategies appropriate to each part of the integrated strategic and tactical models. It determines the hardware, software and communication facilities, and the physical design and development of defined information systems and expert business systems. [Ref. 16: p. 231]

Conventional files, DBMS products, 3GLs and 4GLs, or expert systems may be used to represent the data in the applications development process. This phase defines the physical implementation of data, systems and reports.

3. Assessment of Information Engineering

Information engineering results in the construction of a data architecture. Data that is vital to the enterprise and the decision making process is identified and documented. IE is "objectives driven" in that goals and objectives are set forth for all levels of the organization. Also, as a user driven methodology, information engineering extracts essential knowledge to confirm that applications meet the users' needs.

Information engineering is an evolutionary process with data being constantly elaborated and enhanced, as well as consolidated when redundancy is evident. Furthermore, IE provides rapid feedback from management on strategic alternatives through the use of what-if scenarios. As a highly automated methodology, IE relies upon data dictionaries, data bases and knowledge bases which are updated automatically affecting consistency and integration of models.

D. COMPARISON OF ENTERPRISE ARCHITECTURE PLANNING AND INFORMATION ENGINEERING

Enterprise Architecture Planning and Information engineering are both data-driven approaches. EAP is a planning methodology whereas IE is a highly developmental methodology. The strategic planning conducted in IE occurs prior to the official start of the project. Planning within EAP is conscious and deliberate from the beginning through implementation. Moreover, the structure of each methodology is quite different. EAP incorporates three levels comprising seven phases in its methodology whereas IE has only three phases. The few corollaries that can be drawn between EAP and IE primarily correspond to the data modeling phase.

The most significant benefit of information engineering is the development of, in EAP terms, a data architecture. However, IE fails to adequately satisfy the application and technology architecture needs of an organization. The combination of the three architectures is important for mapping current data to future requirements. The architectures also provide the necessary documentation of shared data, thereby creating systems and applications which support the organization. IE also does not address the implementation phase to the degree EAP does. The implementation plan seeks to identify all potential obstacles, set milestones, and is structured to maintain organizational

commitment. This phase is essential to the success of an IS architecture.

Enterprise Architecture Planning is an extensive and exhaustive methodology with the primary objective of implementing a project. The attentiveness to planning as an integral part of the whole project sets this methodology apart from all others. The ability to integrate other methodologies adds flexibility and credibility. Information engineering can be an excellent tool within Enterprise Architecture Planning, but as a stand alone methodology, it lacks the comprehensive characteristics and components of EAP.

To support NAVAIR in incorporating EAP principles in their architecture effort, a baseline architecture is proposed in the following chapter.

III. A BASELINE ARCHITECTURE FOR NAVAIR

A. PREVIOUS ARCHITECTURE EFFORTS

1. AIR-04 ISP

The Aviation Logistics department of the Naval Air Systems Command published the AIR-04 Information Strategy Plan (ISP) in March of 1989. The ISP was based largely upon a combination of IE methodologies. Although the effort devoted to this plan was extensive, it was not successful by EAP standards, since it was not implemented. The most significant problem which affected every aspect of the project was the lack of a clear and concise scope which had the consensus of the participating team members. [Ref. 17: p. 9]

The overall scope of this project was established by department, AIR-04, and not by functional areas within NAVAIR. This resulted in an inability to adequately document areas outside of AIR-04. Furthermore, the functional areas chosen by the ISP team members were along the following departmental versus functional lines: Administrative Support, Policy and Planning, Property Management, Program Management, Operations Support, Financial Management. The AIR-04 ISP failed to define and document the information flows in sufficient detail, as well as how information is shared, and therefore,

could not be effectively implemented within the Aviation Logistics department or NAVAIR. [Ref. 17: p. 33]

2. NAVAIR CIMP

The Component Information Management Plan (CIMP), promulgated annually, sets forth NAVAIR's policy for information resources/information systems (IR/IS) support. The CIMP "reflects a critical analysis of IR/IS requirements and priorities" [Ref. 18: Foreword] and CIMP incorporates the Information Requirement Plans (IRP) which are divided into seven functional areas:

- Logistics
- Systems and Engineering
- Contracts, Administration and Business
- Financial Management Systems
- Local Area Networks
- Local OA/AIS Systems
- Support Systems

Within each functional area are the listings of all information systems which support the various NAVAIR information requirements. The IRP provides substantial detail on the information requirements, management, resource support, architecture, and resource requirements (budget) of each system.

While the CIMP is partitioned initially by functional areas, the information systems within each area are not. Furthermore, no mission statement or executive overview is provided as justification or support for the functional area. The attention given to individual systems needs to be extended to the functional areas to ensure cohesiveness and validity of existing systems.

B. A BASELINE ARCHITECTURE

The AIR-04 ISP and the CIMP contribute valuable information and lessons learned to begin a baseline architecture. This effort is not intended to be comprehensive but rather a starting point, implementing EAP techniques, to assist NAVAIR in identifying key steps in developing an overall IS architecture. The baseline architecture coincides with the Functional Business Model (FBM) discussed in Chapter II, and focuses only on the Logistics functional area.

Beginning with the deficiencies noted in Section A, functional areas must be defined by what NAVAIR does. The functional areas designated by the CIMP are sufficient for this purpose (Figure 3). To determine the functional areas that exist within Logistics, a comparison of the information systems is required. Twenty systems are currently supported by Logistics (Figures 4 and 5). The highlighted words in Figure 5 denote common characteristics of these functions/

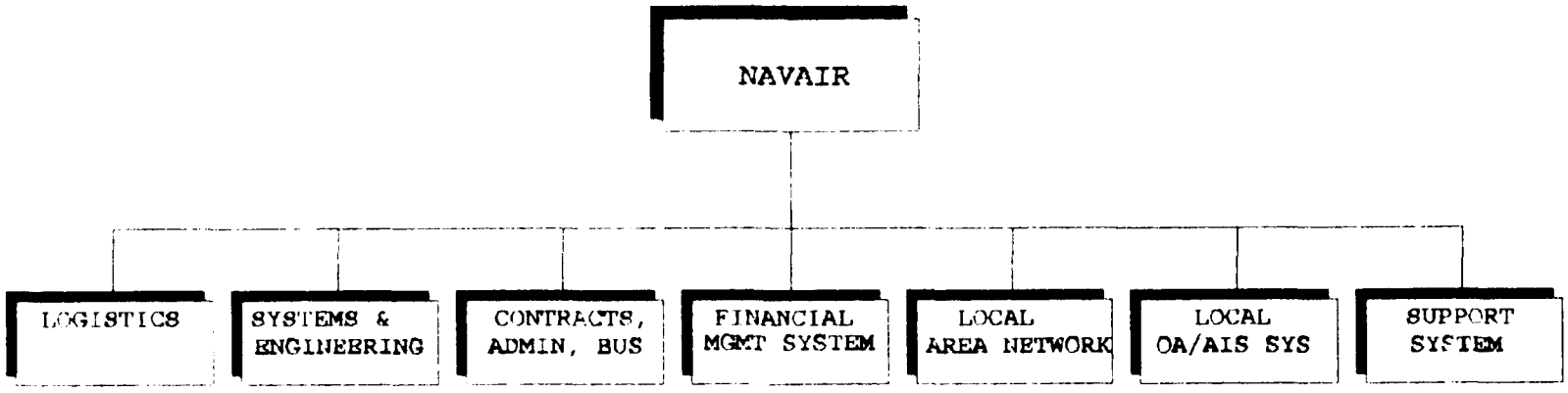


Figure 3. NAVAIR Functional Areas [Ref. 18]

NAVAL AIR SYSTEMS COMMAND

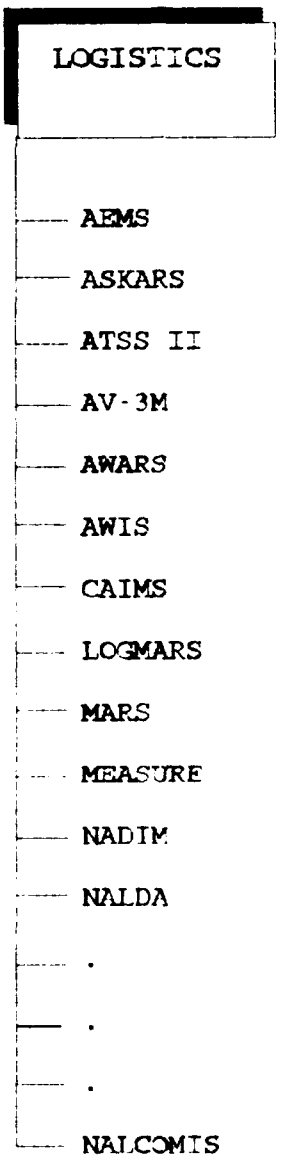


Figure 4. Logistics Information Systems [Ref. 18]

SYSTEM	ABBREV	DESCRIPTION
Aircraft Engine Management System	AEMS	Naval aviation engines, maintenance
Automated Storage, Kitting and Retrieval System	ASKARS	NAVAVNDEPOT, production control division
Aviation Training Support System - Phase II	ATSS II	fleet replacement squadron training, support systems
Aviation 3-M System	AV-3M	maintenance and logistics management
Airborne Weapons Analysis and Reporting System	AWARS	airborne weapons
Airborne Weapons Information System	AWIS	airborne weapons
Conventional Ammunition Integrated Management System	CAIMS	weapons
Logistical Marking and Retrieval System	LOGMARS	material movement
Management Action Reporting System	MARS	supports maintenance for airborne weapons
Metrology Automated System for Uniform Recall and Reporting	MEASURE	calibration of TAMS, AV-3M interface, maintenance
Naval Aviation Depot Information Management	NADIM	NADEP IS, interfaces: NIPMS, NIMMS, WCS, ASKARS
Naval Aviation Logistics Data Analysis	NALDA	critical aviation maintenance and logistics AIS
NAVAIR Industrial Material Management System	NIMMS	NADEP material management:WCS, NIPMS, ASKARS
Rapid Acquisition of Manufacturing Parts	RAMP	manufacture and support weapons systems
Support Equipment Resources Management Information System	SERMIS	aviation support, maintenance
Supply Department Information System	SUDIS	supply support for Point Mugu, material support
Uniform Automated Data Processing System	UADPS	automated NSP financial supply
Workload Control System	WCS	NADEP IS: NIMMS, NIPMS, ASKARS
Work-In-Progress Inventory Control System	WIPICS	components, maintenance, NADEP: NIMMS, ASKARS
Naval Aviation Logistics Command Management Information System	NALCOMIS	support aviation maintenance, AV-3M, UAD

Figure 5: Logistics Information Systems [Ref. 18]

systems. Compiling like systems results in five functional areas: Maintenance, Material/Supply, NADEP (NAVAVNDEPOT), Training, and Weapons (Figure 6).

In reviewing Figure 6, several factors become evident. First, many of the functional areas have numerous systems which indicates possible redundancy. Furthermore, within each area, there is at least one major information system which may be able to subsume some or all of the smaller systems. For example, the Naval Aviation Depot has five information systems, each using some data from the others. The Naval Aviation Depot Information Management (NADIM) seems to be a comprehensive system which may be able to incorporate others and thus reduce redundancy. One peculiarity arises in the Material/Supply functional area; SUDIS is unique system designed specifically for Point Mugu. It may be possible for that system to be subsumed by a larger IS or within another functional area, or based upon its "unique" contribution to that functional area, remain unchanged.

Another factor is that within most of the functional areas, functional decomposition can be continued facilitating further consolidation or identification of redundancy. Within the Weapons area, three subfunctions are identifiable by their single action orientation (Figure 7). Finally, several systems can be assigned to more than one functional area. This is acceptable as long as the information flows are

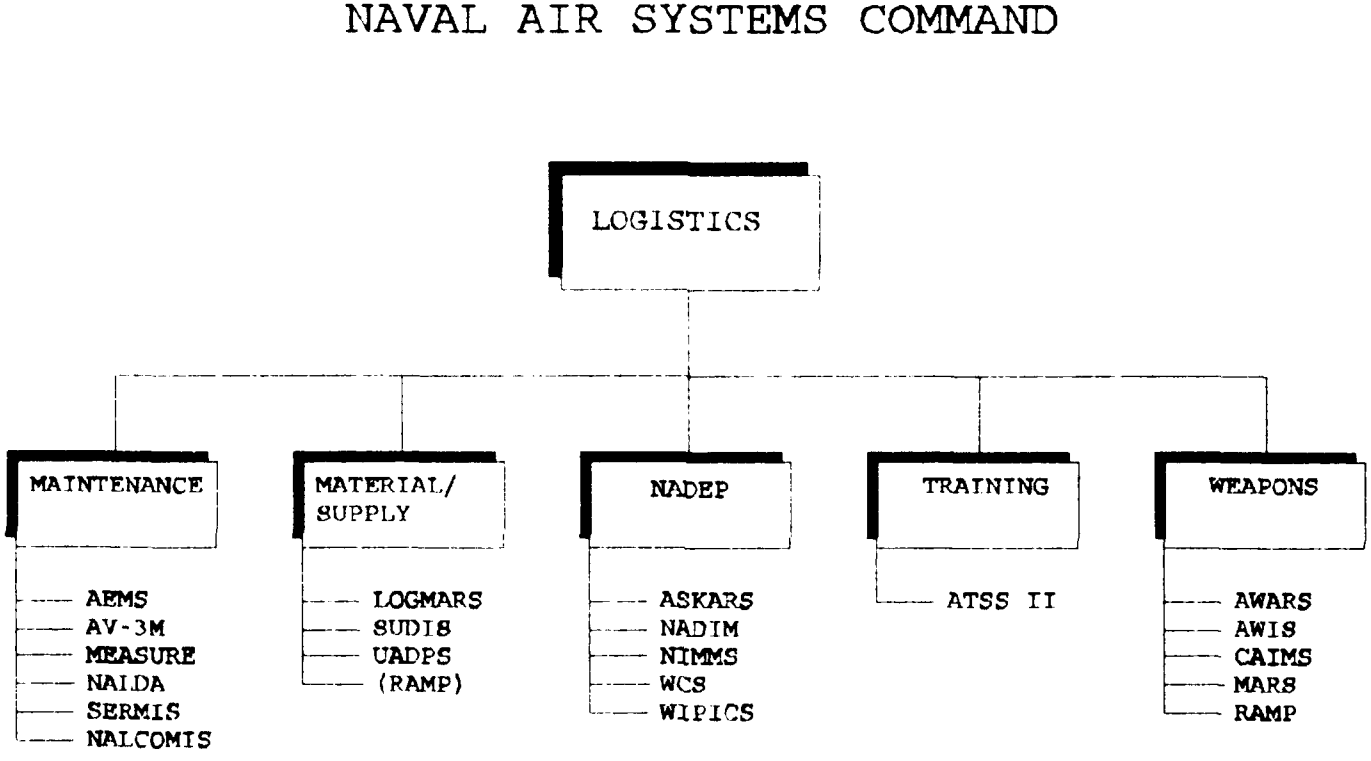


Figure 6. Logistics Functional Areas (NEW) [Ref. 18]

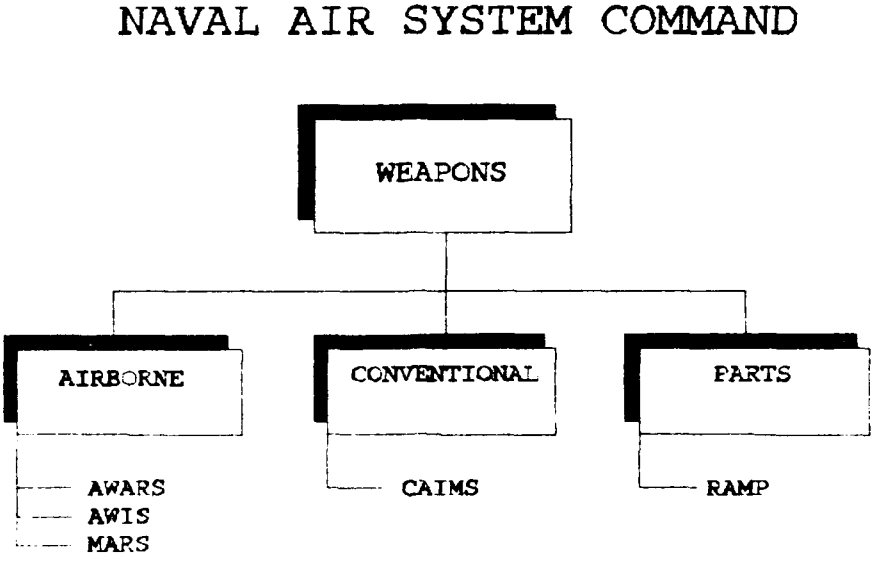


Figure 7. Weapons Functional Areas [Ref. 18]

correctly identified, documented, and any redundancy eliminated.

Upon analysis of the budget sheets provided for each information system, it is evident that NAVAIR is consolidating systems within functional areas (Figure 8). Again using Weapons, individual budget sheets for AWARS and MARS indicated that these ISs cease to exist as standalones in FY91 and become applications of AWIS. Another IS, CADMSS, is also integrated into AWIS, however, a description is not provided in the CIMP. The budget implications for functional areas are best identified if budget sheets are consolidated. The sheet for Weapons gives valuable insight into the allocation and appropriation of funds and where consolidation of resources may be beneficial.

As mentioned with regard to the AIR-04 ISP, true functional areas cannot be sufficiently determined without evaluating NAVAIR as a whole. Many of these systems are used by other departments and functional areas. The entire organization must be taken into consideration to attain a true picture of how information is utilized within NAVAIR.

WEAPONS FUNCTIONAL AREA
(AWARS, AWIS, CAIMS, MARS, RAMP)*
($ in thousands)

APPROPRIATION		FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97
NIF(RAMP ONLY)									
	RQMT	45	370	430	310	285	315	295	285
	BUDGET	0	0	0	0	0	0	0	0
	DELTA	45	370	430	310	285	315	295	285
O&MN									
	RQMT	2765	4318	4291	4432	4139	4317	4463	4615
	BUDGET	1492	4264	3706	3224	3093	3201	3310	10
	DELTA		54	585	1208	1046	1116	1153	
OPN(RAMP ONLY)									
	RQMT	550	1400						
	BUDGET	0	0						
	DELTA	550	1400						
RDT&E									
	RQMT	80							
	BUDGET	80							
	DELTA								
OTHER (specify)									
	RQMT								

*It is believed CADMSS is included in these figures, however no budget data was provided in the CIMP.

Figure 8: Weapons Budget Sheet [Ref. 18]

IV. OVERCOMING BARRIERS TO IMPLEMENTATION

Numerous information systems architectures have been attempted by civilian and government organizations. However, few IS architectures have been implemented and utilized. Internal and external environments affect every stage of the planning process. These environments can create barriers to implementation and must be managed throughout the entire effort.

NAVAIR faces four barriers to successful implementation of their architecture.

1. Inconsistencies in *approaches to planning* profoundly affect the portability of applications and the capability to integrate systems. Planning must be initiated at a level that ensures information systems evolve according to the needs of the enterprise.

2. Misinterpretation of *organizational culture* can lead to extreme opposition to an IS effort. The culture determines how best to present and attain support for the project.

3. Fluctuations in *political climate*, primarily within DOD, have a direct impact upon the priority an IS architecture receives. The internal and external environments must be stable and well managed to guarantee consistent backing.

4. Inadequate *senior management involvement* will reduce the effectiveness and efficiency of information systems. The effort must have substantial organizational importance to secure commitment and support from all members of the organization.

These barriers can seriously impede the progress of a project, resulting in an ineffective effort and even failure of a project.

A. APPROACHES TO PLANNING

Planning must be initiated at a level that ensures information systems evolve according to the needs of the enterprise. If the approach is too localized or departmental it will lack connectivity to the overall organizational plan. Conversely, if the approach is too broad, the architecture may lack sufficient detail to develop operational information systems.

The two approaches to business planning are bottom-up and top-down. Bottom-up planning, the most commonly used, is conducted at the departmental level and is primarily concerned with preserving budgets rather than addressing business functions. This approach often creates plans which are independent of other activities within the organization resulting in non-standard, non-integrable systems that rarely meet or comply with organizational strategies.

The second approach, top-down, dictates that planning is initiated at the top through a collaborative effort between senior management and functional managers. Greater commitment from subordinates is gained through this process. Furthermore, consistency with overall goals and objectives is maintained. However, top-down planning may inadvertently omit

vital information known only by users deep within the organization.

To prevent planning from becoming an implementation barrier, the best approach is a combination of the two. Direction and strategic guidance are provided at the top, while detailed planning formulation and implementation is conducted deep within the organization. Senior management monitors and reviews plans to ensure congruity and cohesiveness for effective implementation.

Functional managers are critical to the planning process in that they are best able to identify their detailed IS requirements and help correlate or translate them into the overall plan. Furthermore, functional managers must be able to justify how their current or future systems impact the organization's mission. For example, if a functional area within NAVAIR requires a new material management IS, its impact on the organization's overall mission and other ISs must be explicitly defined to top management. The impact statement should include the drastic reduction in the location and dispatch time required for aviation parts and the benefits of the elimination of two information systems.

The IS architecture team must effectively illustrate the value of this planning approach to obtain the organization's endorsement and to guarantee the process is valuable. The effect of systems that are inconsistent with, or that have little relevance to, the organization's overall mission

(whether imprudent, redundant, or non-integrable) must be made clear by the team.

B. ORGANIZATIONAL CULTURE

The disregard, or inaccurate identification, of corporate culture will result in serious resistance to implementation. As discussed in chapter two, "the purpose of culture is to provide members with a sense of identity and to generate a commitment to beliefs and values that are larger than themselves." [Ref. 13: p. 14] These beliefs and values can blind management to the significance of changing their environment as well as inhibit change if management considers their present practices successful.

Changing corporate culture is a very complex and delicate process, especially if it has been perpetuated in the strictest traditions over time, as with the military. However, the consequence of not transforming the structure is the perpetuation of ineffective, redundant, costly systems in an era of diminishing resources. Organizations should be configured based on their information needs and how information supports their overall missions. This could result in an alteration of the organization's culture. However, if a change is warranted, a plan must be developed within the framework of the existing culture, identifying any potential cultural risks. [Ref. 13: p. 15] Since corporate culture represents the beliefs and values of its leadership,

it is imperative that any paradigm shift from a department to functional area organizational structure be initiated by top management. Further, the shift must be frequently monitored and post-implementation criteria established to prevent the reduced impact of change over time.

It is unrealistic for management and staff to expect overnight benefits from an IS architecture (Figure 9). The immediate impact of change will be reduced efficiency and effectiveness, confusion within the organization and an increase in staff turnover. [Ref. 19: p. 8] The intermediate impact is the increase in resources expended and the temporary erosion of the organization's value system as "a new corporate equilibrium is reached." [Ref. 19: p. 8] The desired long-term effect of change is "on efficiency of operations (costs); effectiveness of products or services; quantity and quality of information; and corporate culture/management culture." [Ref. 19: p. 8]

The human element must be managed to affect a cultural change thereby implementing a new technology. No longer is it sufficient to identify the process and technology needed to increase the effectiveness and efficiency of a business. It is vital that the members of the organization accept and support the recommendations for implementation to achieve success.

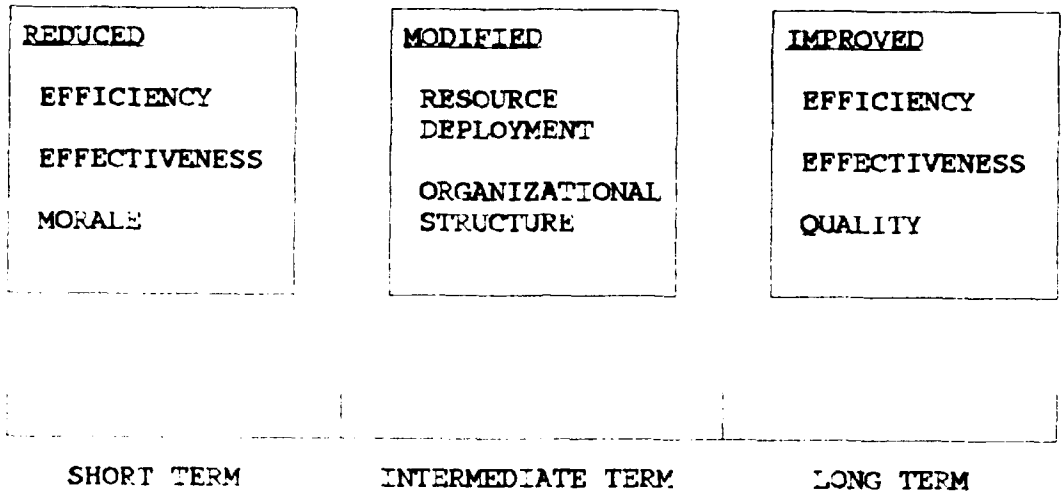


Figure 9. Impact of Change Over Time [Ref. 19: p. 7]

C. POLITICAL CLIMATE

An information systems architecture is not so dependent on the importance of its ideas and principles as it is on the charisma and the credibility of its leadership. Currently, the CIM initiative, and more specifically Paul Strassman, is the driving force behind all DOD IRM and ADP issues. New developments and modernizations have been curtailed and the entire Department of Defense is in a state of flux waiting for firm policy decisions and mandates, as well as product selection. Buzzwords depicting CIM's direction change frequently. Current buzzwords include re-engineering, reusable code and benchmarking. Two concepts that have had decisive political impact on information technology (IT) within DOD are TQM and, most recently, IDEF.

1. TQM

Total Quality Management (TQM) became a military, and political, concept in 1990. It is an approach to changing management practices which have been in effect for decades. "TQM is a management philosophy and approach that brings together a complete set of management principles and techniques for an organization to survive and grow in the 1990's" [Ref. 20: p. 7-1] IS/IT efforts are required to be aligned with TQM. IT supports TQM as a "holistic management approach":

- Considers the total system (i.e., all management processes and their interfaces)...all of the components within a system and the people that work in it must work toward the aim of the organization.
- Employs a complete set of hard (engineering) and soft (personnel) management sciences. Leadership behavior must be fine-tuned to energize each unique individual to think and work toward his or her potential. Team efforts should be expected to produce results that are greater than the sum of the individual parts.
- Involves and benefits managers, employees, customers, and suppliers. [Ref. 20: p. 5-1]

The impact of IT on TQM is that it provides the means for determining what processes need improving and the analytical tools to complete the task. TQM is designed to force the flow of information both up and down the chain of command, while assuring consistency and accuracy of meaningful and shared data.

The combination of IT and TQM promises to give organizations a definitive strategic advantage (Figure 10). The precepts of TQM coupled with those of CIM require senior officials and IS/IT teams to possess the political savvy to ensure all specifications have been suitably addressed and documented.

2. IDEF

Integrated Definition (IDEF) language is the latest methodology to be selected by CIM for DOD implementation. An extensive training effort is currently underway to educate

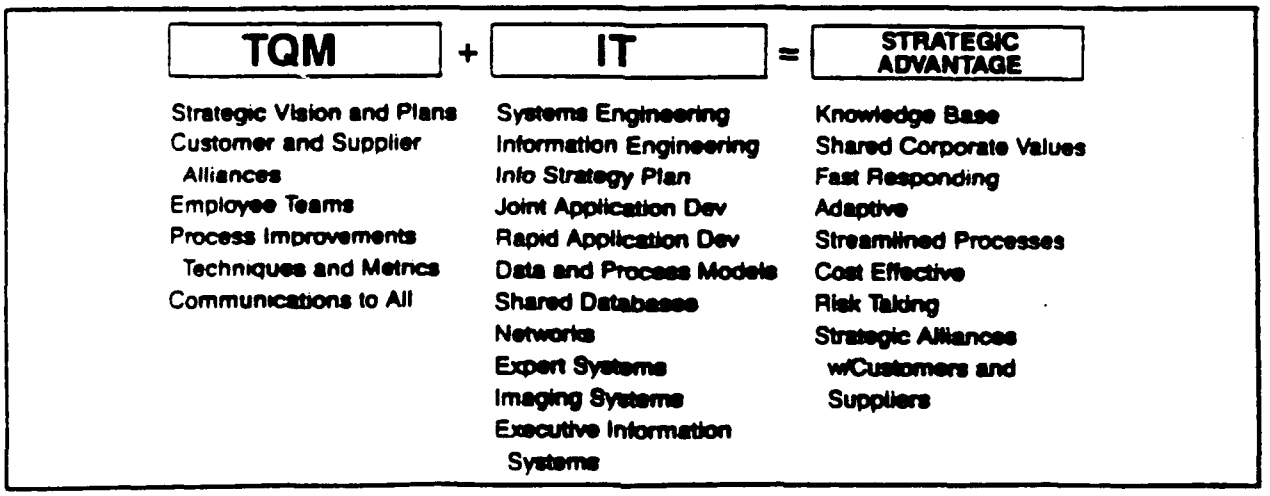


Figure 10. Strategic Advantage Success Formula [Ref. 19: p. 7-1]

senior IS executives and functional managers, including the members of the CIM executive groups.

> IDEF also presents managers with choices that they would not even consider using other methods, including completely eliminating the process or activity, revamping procedures or the judicious application of information technology to help solve the problem. [Ref. 21: p. 10]

Developed by the Army Corps of Engineers, IDEF is a process driven, planning methodology that provides a framework for building an IS architecture.

The Navy is currently evaluating IDEF for use service-wide. The Naval Information Systems Management Center (NISMC) is evaluating seven IS project proposals submitted by the Navy IDEF Workgroup. These projects consist of information systems from various commands. NISMC will select prototype projects which will commence in April 1992 and must be scoped to ensure completion in 120 days. These projects will determine the strengths and weaknesses of IDEF and ascertain if IDEF toolsets are user-friendly as well as the level of expertise required to use them. The recommendations made to NISMC will be valuable in determining IDEF's future role within the Navy.

3. Other Efforts

As illustrated by IDEF, there is a concerted effort underway by the services to cooperate with the CIM initiative. Each service is feverishly working to develop or evaluate the one architecture that will become the standard. What must be understood is that there may not be "one" single methodology

that can be applied to each service or even to each department within the services. Sufficient room for interpretation must be allowed for the adaptation and manipulation of methodologies within specific organizational cultures. Another political barrier is the issue of ownership. Intra- and inter-service power plays can seriously hinder implementation. If one methodology produced by a service, major command or department, is forced on other agencies, the natural, human nature response of rivalry, resentment and resistance can hamper implementation.

a. NAMO effort

Several IS architecture efforts are currently underway in the Department of Navy. For NAVAIR, the Naval Aviation Maintenance Office (NAMO) has been chartered to develop a prototype Information Strategy Plan (ISP) and a Data Administration (DA) Program for aviation logistics. This effort, initiated approximately one year ago, has been severely hindered by politics in the following ways:

1. Scope: Broadly defined, the data collected for the DA program has grown exponentially. Difficulty now exist now in how to utilize all the information gathered.
2. Personnel: There are only six members assigned to the NAMO project, none of whom is full time. Other activities have taken precedence over the ISP and DA resulting in a four month suspension until April 1992.
3. CIM: The requirements and directives for CIM frequently conflict with methods already in progress requiring IS/IRM divisions to be increasingly flexible.

4. Cooperation. Significant collaboration is required between NAMO, NAVAIR, and other DON agencies. Dissension has been expressed by others regarding NAMO's choice of methodology (James Martin's IE), case tool, and the scope of the project being too unique to aviation logistics. However, the NAMO team has received support from senior officials which enhances their credibility.

Politics are inherent to the government and the military. Credibility, seniority and authority all profoundly affect political decisions. Moreover, with the high rate of turnover built into the services, what is important to one commanding officer or director may be superseded by the new goals and objectives of his/her relief or by those of a new boss. One senior official may envision IS architectures as critical, whereas another may determine the installation of a local area network (LAN) to be mission essential. Both deal with IRM issues, but if instituted imprudently, they can severely thwart projects already in progress.

D. SENIOR MANAGEMENT INVOLVEMENT

Underlying all of the challenges to implementation is the degree of involvement by senior officials. Senior management is the catalyst for the entire effort. Top management must allocate sufficient resources, people, funding, necessary tools and hardware, for an IS architecture to be successfully implemented.

Senior management must ensure there is a balanced data administration (DA)/IRM strategy (Figure 11). The short-

term/tactical benefits must be assessed prior to addressing long-term/strategic projects. Data is standardized through the use of data dictionary tools, which then becomes the backbone for all architectures and maintenance support.

STRATEGIC	Development Support	Re-engineering Attitudes
TACTICAL	Data Standards	Data Connectivity
	DP ORIENTED	**BUSINESS ORIENTED**

Figure 11: A Balanced DA/IRM Strategy

Frequently, data standards have been the primary focus of IRM plans resulting in a too limited scope. Here, data is coupled to business uses as end-users are given access to appropriate existing sources of information (i.e., archives, files, screens, etc.) primarily supporting operation, but also decision support, areas.

Once the tactical aspects are underway, the strategic elements can be satisfied. Development support is established for the construction of a data architecture. The redevelopment of standard interfaces and models is conducted based on the strategic needs of the organization. Also crucial in long-term planning is the re-engineering of organizational attitudes toward the importance of information through

education and top-down planning. Again, the pressure for a paradigm shift must come from the top for success to be achieved. The balance between the tactical and strategic focus for DP and business issues provides valuable direction for senior management involvement in guaranteeing both short- and long-term success.

The impact top management involvement has on IS development is illustrated in a survey conducted of thirty-three firms (Figure 12). While a relatively small sample, this survey suggests clear guidelines for success in IS development. Suggested levels of involvement by the senior official are depicted in Figure 13. Although not an accepted practice, it is critical that the senior executive insist on the development of a long-range IS plan and ensure it is consistent with organization strategies. The senior official's involvement throughout the IS effort impresses upon both the implementors and the entire organization the importance and pertinence of the project.

To gain top management support at the outset, NAVAIR's IRM division must make it clear that the purpose of the IS plan is to demonstrate to management that they understand the organization and possess a sound basis for documenting and developing information systems. [Ref. 6: p. 18] Furthermore, the team should point out that the IS architecture effort will result in both intended and unintended benefits to management.

Yes to:	*Firms with Unsuccessful IS Development*	*Firms with Successful IS Development*
Executive Steering Committee Do you have a system policy committee, comprised of managers from functional areas of the organization, involved in setting priorities and/or allocating resources for systems development?	*23.1%*	*55.0%*
Written Plans Do you have a written overall plan for systems development which (1) covers all major functional areas of the business, and (2) clarifies inter-relationships between applications (systems)?	*23.1%*	*60.0%*
Development Priorities Do you and higher level management have a mutually agreed upon set of criteria for deciding which applications (systems) to implement first?	*46.2%*	*90.0%*
Funding Committee Has top management made a long-term commitment to provide stable funding for system development activity?	*38.5%*	*70.0%*

Figure 12. Results of Application Development Survey [Ref. 21: p. 311]

Activity	*Approve*	*Insist*	*Review*	*Delegate*
Long-range IS plan	X	X		
Determinitation of application portfolio			X	
CEO decision support system specification	X			
IS budget and resource allocation			X	
Security/backup plan		X		
IS mission statement		X		
Selection of IS executive			X	
Technological risk assessment	X	X		
Design of systems				X
Hardware/software selection				X

Figure 13. CEO Involvement Levels [Ref. 21: p. 312]

Intended benefits include:

- Information is managed as a strategic corporate resource.
- System priorities can be more comprehensively understood.
- Functional redundancy can be identified.
- Systems development will be more cost-effective. [Ref. 6: p. 17]

Some additional benefits are:

- Data administration functions are reviewed in order to capitalize on the benefits of data reusability and shared integrated systems.
- Healthy cross-education between users and MIS personnel may occur, indirectly reducing systems design errors.
- Cooperation between different parts of the company that perform similar function may increase. [Ref. 6: p. 17]

An IS architecture provides a vehicle to manage data better and to develop more cost efficient, effective systems that add value to the organization. The IRM division must impress on management the realization that any improvements generated by the effort directly correspond to the organization achieving its business objectives.

Senior management support is essential to implementation of an IS effort. Top management which is either too involved or too complacent can adversely affect implementation. They must be able to determine what is best for the organization and its culture while complying with the existing political environment.

V. RECOMMENDATIONS

The Naval Air Systems Command needs an organization-wide information systems architecture. The many architecture efforts which are currently in progress should be suspended and a comprehensive evaluation of IS/IRM accomplishments should be examined. Viable portions and/or successful projects should be selected for possible adaptation for a command-wide architecture. This suspension is critical for NAVAIR headquarter's to gain management control of information resources, as well as to enforce standardization throughout the organization.

The IRM division, AIR-713, must evaluate Enterprise Architecture Planning to determine its feasibility as a methodology for the organization. It is recommended that initially consultants be retained to provide preliminary guidance and training. Once EAP has been officially accepted, preparatory training programs should be developed and instituted throughout the organization. To gain commitment and cooperation, training must begin with headquarters and senior management, and filter down.

The project must commence as a top-down planning approach. It is vitally important to the success of this effort that the team include business and systems personnel and management and

users from field commands. This is essential for ownership to be gained at the outset. These persons are best identified during the initial training sessions. Understanding the vastness of NAVAIR, tele- and video-conferencing should be utilized whenever possible to minimize the impact on funding. Electronic mail (E-mail) can also serve to optimize currently available IT.

As the team and project progress, the reorganization or redesignation of functional areas with NAVAIR will become apparent. The organization's culture must be accurately identified and planned for this to be successful. Again, outside consultants may be useful and worth the expense to ensure that strategy is developed correctly and satisfies the needs of the organization.

EAP can be easily adapted to any requirements, methodology, or tools selected under CIM. IDEF corresponds well to level I and II of EAP. To gain the strategic advantage, however, the last two levels must be performed. The architecture and implementation phases confirm that data has been properly documented and that systems and applications created will meet organizational requirements and can be integrated.

As DOD awaits CIM selection of a standard toolset, specifically I-CASE, it is not suggested that new tools be purchased. Several toolsets are already in use within NAVAIR. Texas Instrument's Information Engineering Facility (IEF) has

been widely used by NAVAIR and is recommended for continuation until the standard tool is promulgated. IEF is a fully integrated CASE product that supports the entire life cycle. The current IEF environment is included in Appendix A. Upgrades to existing software are more economically feasible at this time.

The use of Enterprise Architecture Planning and the tools and resources currently available will enable NAVAIR to achieve the long-term goals of improved productivity, efficiency, effectiveness and quality while reducing costs. The decision making process will be greatly enhanced providing better utilization of resources. EAP will allow NAVAIR to adapt quickly to the rapidly changing CIM environment.

The savings promised by CIM are overestimated. The development of an IS architecture, the consolidation of systems and departments, coupled with the reduction of personnel, will require significant up-front dollars and resources. However, the CIM mandate is permanent. NAVAIR must work to adhere to its precepts and directives to ensure that reductions in resources do not adversely affect the organization's military mission. A comprehensive, command-wide information systems architecture will provide the best mechanism for achieving that objective.

A. FOLLOW-ON STUDY AREAS

The following is a list of areas which would be beneficial in assisting NAVAIR with an IS architecture:

- A case study of one or more organizations, non-profit and/or of similar size, which have successfully completed and implemented an information systems architecture.
- A case study of the organizational culture of NAVAIR. This would be of great importance to the IS effort as well as save considerable time.
- Provide overviews of tools chosen and supply critical cost/benefit analysis for systems and technology.

The Naval Air Systems Command IRM division is actively pursuing solutions to its information systems architecture requirements. High-level discussions are in progress to evaluate viable options. Several significant architecture projects are underway but are of limited scope. NAVAIR must develop a command-wide architecture to identify and eliminate redundancy and to produce more cost-effective systems that meet the needs of the organization. The proposed comprehensive effort will provide NAVAIR with a strategic advantage in an era of diminishing resources.

APPENDIX A

[Ref. 23: p. 6]

Texas Instrument's IEF Environment for DP/MIS Applications

A. Life Cycle Phases Supported:

1. Program Management
2. Method Management
3. Strategic Systems Planning
4. Analysis
5. Design
6. Code (Application) Generator
7. Configuation Management
8. Reverse/Re-Engineering

B. Methods Supported:

1. Information Engineering

C. Languages Supported for Applications:

1. Cobol

D. DBMS Supported for Application:

1. DB2

E. Platforms/Operating Systems for Development:

1. IBM MVS
2. TSO
3. ISPF
4. TI Bus Pro

5. IBM PS/2

6. PC-AT

F. Price:

1. approx. $200K +

G. Representative Data Dictionary/Repository Tools:

1. Integrated main-frame based repository.

2. Supports IBM's Repository Manager.

H. Future Phase and Method Support:

1. Ada Code Generator

2. Object Oriented Analysis

3. Open Application Systems

LIST OF REFERENCES

1. Department of Defense, **Defense Management Report to the President**, July 1989.

2. Department of Defense, **Defense Management Report to the President**, March 1991.

3. **Overview of DOD CIM**, Allhands-15 1991.

4. Department of Defense, "A Plan for Corporate Information Management for the Department of Defense", 11 September 1990.

5. Department of Navy, "DON Information Resources (IR) Strategic Plan", April 1991.

6. Cheung, Steven C.K., "Avoiding the Pitfalls of Information Systems Planning", **Data Resource Management**, Auerbach, Summer 1990.

7. **Information Resource Management Plan Summary**, 1991.

8. Zachman, John, "A Framework for Information Systems Architecture", **IBM Systems Journal**, Vol. 26, No. 3, 1987.

9. Brancheau, James C., et al, "Building and Implementing an Information Architecture", **DATA BASE**, Summer 1989.

10. Dickson, Gary, and James Wetherbe, **The Management of Information Systems**, McGraw-Hill, NY, 1985.

11. Spewak, Steven H., **Managing Enterprise Architecture Planning**, Digital Consulting Inc., 1991.

12. Schein, Edgar H., **Organizational Culture and Leadership**, Jossey-Bass Publishers, 1985.

13. Sankar, U., "Organizational Culture and New Technologies", **Journal of Systems Management**, April 1988.

14. McNurlin, Barbara Canning (editor), "Influencing Corporate Policy", **I/S Analyzer**, vol 26, No. 6, June 1988.

15. Linder, Jane, "Harnessing Corporate Culture", **Computerworld**, 23 September 1985.

16. Finkelstein, Clive, **An Introduction to Information Engineering: From Strategic Planning to Information Systems**, Addison-Wesley Publishing, 1989.

17. Naval Air Systems Command AIR-04, "How-To Guide and Lessons Learned", DON, 1989.

18. Naval Air Systems Command, **Component Information Management Plan**, DON, 1991.

19. Herzog, John P., "People: The Critical Factor In Managing Change", **Journal of Systems Management**, March 1991.

20. Gardiner, David C., "Strategic Advantage in the 1990's: Total Quality Management Enabled by Information Technology", **NASWC TR9113**, January 1991.

21. Brewin, Bob, "CIM", **Federal Computer Week White Paper**, September 1991.

22. Kanter, Jerome, **Managing with Information**, Prentice Hall, 1992.

23. "Technology Guide", **Executive Briefing: CASE**, January/February 1991.

BIBLIOGRAPHY

Brancheau, James C., et al, "Building and Implementing an Information Architecture", **DATA BASE**, Summer 1989.

Brewin, Bob, "CIM", **Federal Computer Week White Paper**, September 1991.

Bryson, John M., **Strategic Planning for Public and Nonprofit Organizations**, Jossey-Bass Publishers, 1991.

Chandler, John S. and H. Peter Holzer, **Management Information Systems**, Basil Blackwell, 1988.

Cheung, Steven C.K., "Avoiding the Pitfalls of Information Systems Planning", **Data Resource Management**, Auerbach, Summer 1990.

Connor, Denis, **Information System Specification and Design Road Map**, Prentice Hall, 1985.

Daniels, Alan and Yeates, Donald. **Systems Analysis**, SRA, 1971.

Department of Defense, "A Plan for Corporate Information Management for the Department of Defense", 11 September 1990.

Department of Defense, **Defense Management Report to the President**, July 1989.

Department of Defense, **Defense Management Report to the President**, March 1991.

Department of the Navy, "DON Information Resources (IR) Strategic Plan", April 1991.

Dickson, Gary, and James Wetherbe, **The Management of Information Systems**, McGraw-Hill, 1985.

Finkelstein, Clive. **An Introduction to Information Engineering: From Strategic Planning to Information Systems**, Addison-Wesley Publishing, 1989.

Gardiner, David C., "Strategic Advantage in the 1990's: Total Quality Management Enabled by Information Technology", **NASWC TR9113**, January 1991.

Herzog, John P., "People: The Critical Factor In Managing Change", **Journal of Systems Management**, March 1991.

Information Resource Management Plan Summary, 1991.

Kanter, Jerome, **Managing with Information**, Prentice Hall, 1992.

Linder, Jane, "Harnessing Corporate Culture", **Computerworld**, 23 September 1985.

Martin, Jmaes, **Strategic Information Planning Methodologies**, Prentice Hall, 1989.

McNurlin, Barbara Canning (editor), "Influencing Corporate Policy", **I/S Analyzer**, vol 26, No. 6, June 1988.

McNurlin, Barbara C. and Ralph H. Sprague, Jr., **Information Systems Management in Practice**, Prentice Hall, 1989.

Murdick, Robert, G. and Ross, Joel E., **Information Systems for Modern Management**, Prentice-Hall, Inc., 1971.

Naval Air Systems Command, **AIR-04 Information Strategy Plan (ISP)**, DON, 1990.

Naval Air Systems Command, **Component Information Management Plan (CIMP)**, DON, 1990.

Naval Air Systems Command, **Strategic Information Systems Plan for the Assistant Commander for Contracts (NAVAIR 02)**, DON, 1989.

Overview of DOD CIM, Allhands-15 1991.

Page-Jones, Meilir, **The Practical Guide to Structured Systems Design**, Yourdon Press, 1988, 1980.

Sankar, U., "Organizational Culture and New Technologies", **Journal of Systems Management**, April 1988.

Schein, Edgar H., **Organizational Culture and Leadership**, Jossey-Bass Publishers, 1985.

Senn, James A., **Analysis & Design of Information Systems**, McGraw-Hill, 1989.

Spewak, Steven H., **Managing Enterprise Architecture Planning**, Digital Consulting Inc., 1991.

"Technology Guide", **Executive Briefing: CASE**, January/February 1991.

Tozer, Edwin E., **Planning for Effective Business Information Systems**, Pergamon Press, 1988.

Zachman, John, "A Framework for Information Systems Architecture", **IBM Systems Journal**, Vol. 26, No. 3, 1987.

INITIAL DISTRIBUTION LIST

1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5002	2
3.	Diane Trobaugh (AIR-713) Director, Information Resources Management Division Naval Air Systems Command (NAVAIR) 1411 Jefferson Davis Hwy, Room 1240 Washington, DC 20361-7130	2
4.	LCDR Robert L. Knight, USN, Code AS/Kt Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5002	1
5.	Professor Daniel R. Dolk, Code AS/Dk Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5002	1
6.	LT Kamin A. Bell Helicopter Combat Support Squadron Three Naval Air Station, North Island San Diego, California 92135-5199	2